

TERRAMODEL NOTE 13

Design Methods

Creating a Design Surface using SMPROAD Command

Objective:

The objective of this TM Note is to describe a process to develop a design surface using the SMPROAD command rather than the DESIGN command. The SMPROAD command will be used to design an auxiliary spillway for an earth dam.

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TERRAMODEL Note 13 - Design Methods

Creating a Design Surface using SMPROAD Command

Example: Emergency Spillway

This method creates a design surface by using the SMPROAD command rather than the DESIGN command. This process involves creating a horizontal alignment (HAL) in the plan view, a vertical alignment (VAL) in the profile view, and a template in the Xsect view mode. The SMPROAD command then creates a design surface using the template for the horizontal and vertical alignments created. Listed below are the steps needed to use this design method to create a design surface for an emergency spillway.

1. Create a horizontal alignment (HAL)
2. Profile the existing ground surface along the HAL.
3. Draw the vertical alignment (VAL) of the design surface.
4. Create a template.
5. Create cross section lines (xlines) used with the SMPROAD design command. (optional)
6. Use the SMPROAD command to create the design surface.
7. Use the DTMSHOT command to zero out the ends of the design surface.
8. Check the design surface.
9. Profile the design surface.

This note was written using the tmodwin menu in Version 9.70.01.

Begin this tutorial with a contour map that has been developed in TERRAMODEL. If you do not have a current project, use the file chapter13.pro as an example. This can be found on the FTP server with this note. Once the project has been downloaded and TERRAMODEL has been opened:

[File]-[Open...]

Select the project chapter13.pro

[Open]

1. Create a horizontal alignment (HAL)

The horizontal alignment (HAL) is simply an alignment created in the plan view using Plines. In this example, the centerline of an emergency spillway is desired. Two intersecting Plines have already been drawn on the contour map, indicating the desired inlet and outlet direction. A curve needs to be drawn to fit these tangent lines.



First, TRIM each tangent line beyond the intersection of the other tangent line.

[Edit]-[Trim]

To bdy ✓

Boundaries: ☐ Pick one of the tangent lines.

Line: ☐ Pick the other tangent line beyond the intersection.

Leave the focus in "Move pt"

Repeat the TRIM command, switching tangent lines.

[Close]

Join the lines so that the intersection of the lines becomes a vertex for the CURVE command.

[Edit]-[Join]

First object: ☐ Pick one of the lines, near the intersection

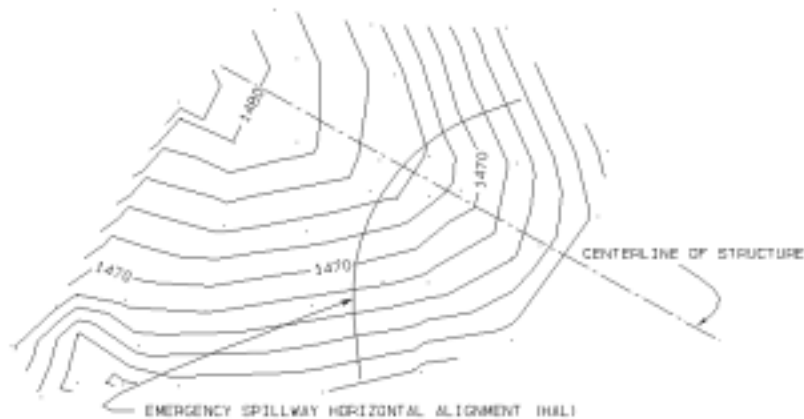
Select lines: ☐ Pick the other line near the intersection.

[OK]

Use the CURVE command to draw a curve to fit the tangent lines. The type of curve selected will be an arc. A curve length of 200' will be selected.

[Draw]-[Arc]-[Curve]
Mode: Arc
Pline:cp: ☐ Choose the intersection
[Curve]
Radius = 200
[OK]
[Close]

Note: You can move the focus to the desired window by either left-clicking on the window or by using the **{TAB}** key. Using the above example, you may click in the distance window to enter 200 or **{TAB}** from the Radius window to the distance window. You can also use **{Shift + TAB}** to go backward, from distance to Radius.



Next, make this curved line a horizontal alignment (HAL). First, STATION the alignment.

Note: If the tangent lines do not appear long enough, or are too long, use the EXTEND or TRIM commands.

[Edit]-[Station]
Alignment: ☐ Pick the curved line.
Beg. Station: **0.00** (to begin stationing at 0+00)
[Station]

Check to ensure that the stationing increases from upstream to downstream.

[Reports]-[Identify station]

Alignment: ☐ Pick the HAL.

Point: ☐ Pick a point near the upstream end of the alignment.

For example:

Offset: -2.700 Station 0+10.04 on Pline r=67 at 9750.05,4982.99

Point: ☐ Pick a point near the other end of the alignment.

[Close]

If the stationing needs to be reversed (for a Pline):

[Edit]-[Edit object]

Obj: ☐ Pick the line.

Click on the down arrow next to Move, and choose Reverse.

[OK]-[Close]

[Close]

Repeat the "Identify station" command to check the stationing.

Give the HAL a unique name:

[Modify]-[Name]

Objs: ☐ Pick the alignment.

New Name: **ESCL**

To display the curve layout information:

[Reports]-[Geometry/Stakeout]

[Plines]

Plines: ☐ pick the HAL

[OK]

Write down the stationing of the PT. We will print the rest of the information later.

[File]-[Close] (On the Document – P3Pad window)

[Close] to exit from the report screen.

[Draft]-[Label HAL] can be used to label the horizontal alignment. See the Command Manual for use of this command.

2. Profile the existing ground surface along the HAL.

First, make the HAL the active alignment:

[Settings]-[Active alignment]
Active alignment: ☐ Pick the HAL.

[DTM]-[Create profile]
HAL: ☐ pick the HAL
Store on: PROFILES (Create this layer)

[Settings]
Dtm layer mask: *
Profile points at: Breaks
Start at station: 0
End at station: 1000

[OK]

[OK]

1 profile(s) stored from station 0+00.00 to 10+00.00

To view the profile:

[Window]-[2 Profile: chapter13]
[View]-[All]

Use a vertical exaggeration of 5:1 to show changes in grade:

[Settings]-[View settings]
Vertical exag: 5.00 (near the bottom of the window)
[OK]
[View]-[All]



3. Draw the vertical alignment (VAL) of the design surface.

Make a new layer ESVAL and make it the current layer.

Draw a point at STA. 3+31.0, Elev. 1466.0

[Draw]-[Point]-[Point]
Loc: **331.0,1466.0**
Z: **1466.0**
Pn: (the default number that appears is okay)
Name: **val**
[Point]
[Close]

Note: If you want the level section to begin at the PT of the curve, enter the station of the PT as determined from the Geometry/Stakeout command used in Step 1.

Draw a Pline from this point, 25' long, level to the right.

Note: Use your right mouse button (right click) for the point snap commands.

[Draw]-[Pline]-[Line]
Loc: ☐ pick the new point
Loc: (right click)-BrgDist
Loc: 331.00,1466.00
Brg: **N90E**
Dist: **25**
[OK]

Add a -1% inlet slope Pline to the VAL:

[New]
Loc: (right click)-End
Endpoint of line: ☐ pick the level Pline near the left end.
Loc: (right click)-DxDy
Loc: 295.00,1467.00 dS: **-100** dE: **-1**
Note: dS is for change in Station, dE is for change in Elevation
[OK]
[Close]

Extend this line to the original ground line:

[Edit]-[Extend]
To bdy ✓
Boundaries: ☐ pick the ground line
Line: ☐ pick inlet line toward left end

Leave the focus in "Move pt"
[Close]

Look at the vertical alignment, inlet slope and level section. If the alignment is not adequate, i.e. the level section is not long enough, or the curve is too long or too short, it would be best to return to the plan view and try a new alignment.

If the VAL and HAL appear satisfactory, finish creating the VAL.

In an effort to have the design surface be created all in cut with no fill, the end of the inlet line will be cut off 20' away from the original ground line. Since the bottom of the emergency spillway is 50', try to picture where the end of the inlet line falls on the contours 25' each way from centerline to determine if it would be in cut or fill and decide if 20' is enough or too much to keep the design surface in cut.

[Edit]-[Trim]
To bdy (no check)
Distance: **20**
Line: ☐ pick the inlet line towards the left end
Leave the focus in "Move pt"
[Close]

Note: This procedure can be done on the right side also. However in this example, the contours are nearly perpendicular to the centerline and the spacing is adequate.

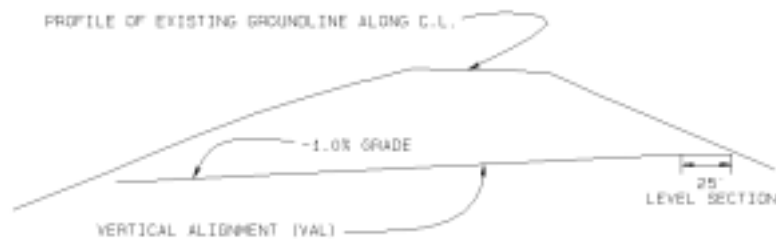
Join the level section Pline with the inlet Pline.

[Edit]-[Join]

First object:  pick the inlet line toward its right end.

Select lines:  pick the level section toward its left end.

[OK]



Name this alignment.

[Modify]-[Name]

Objs:  pick the VAL

New name: **ESCL** (this must be the same as HAL)

[OK]

4. Create a template.

Change display window to XSECT.

[View]-[New view]-[XSECT]

Make a new layer called TEMPLATE and make it the current layer.

The emergency spillway is to have a 50' bottom width, therefore, draw a Pline 50' long with its center at the coordinates 0,0.

Note: If you have your coordinate scroll turned on, notice that the coordinates are in Offset and Elev. To turn the coordinate scroll on, choose [Window]-[Coordinate scroll].

[Draw]-[Pline]-[Line]

Loc: **-25,0 [Create]**

Loc: **0,0 [Create]**
Loc: **25,0 [Create]**
[Close]
[View]-[All]

Make this line a template:

[Cogo]-[Streets]-[SmpTmpl]
Template: ☐ pick the line.

[Properties]

Template name: ESTEMP
Vertical offset: 0
Align sta. from 0: ✓
[OK]

[Left ditch]

Left cut slope: 3:1
Left fill slope: -2:1
Left ditch bottom width: 0.00
Left ditch slope: -2:1
Left ditch name: L_DITCH
Left tie: ✓

[Right ditch]

Right cut slope: 3:1
Right fill slope: -2:1
Right ditch bottom width: 0.00
Right ditch slope: -2:1
Right ditch name: R_DITCH
Right tie: ✓

[SmpTmpl]

Query: This Polyline does not have an attribute. Do you want to add an attribute?
[Yes]

Before the next step, we need to print the curve data for our HAL.

[Window]-[1 Plan: chapter13]

[Reports]-[Geometry/Stakeout]

[Plines]

Plines: Choose the line **[OK]**

[File]-[Print]-[OK] (On the Document-P3Pad window)

[File]-[Close] (On the Document-P3Pad window)

[Close]

5. Create cross section lines (XLINES) used with the SMPROAD design command.

Make a new layer ESXLINES and make it the current layer.

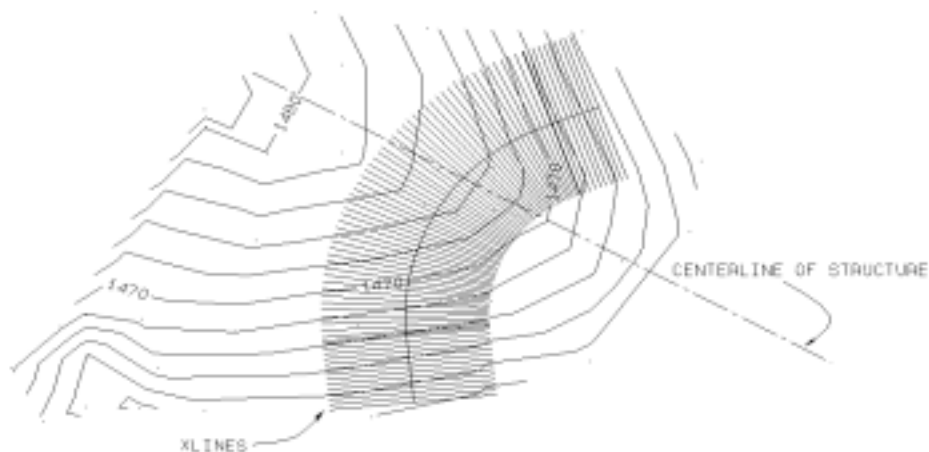
[Draw]-[Pline]-[Xlines]
Horizontal alignment: ☐ pick HAL
Type: Defaults
Left: **75**
Right: **75**
[OK]
[Xline]
Type: [Interval] (Click on the down arrow next to Defaults and choose Interval.)
Begin: & End: Use stationing that appears
Int: 5

Note: The closer the interval the more accurate the design surface, however more memory is also required.

[Xline]
[Close]

Add specific stations along curve (The PC and PT of curve)

[Xline]
Type: [Station] (Click on the down arrow next to Interval and choose Station.)
Station: **67.19** **[Xline]**
Station: **330.66** **[Xline]**
[Close]-**[Close]** to close the command.



6. Use the SMPROAD command to create the design surface.

Make a new layer ESDESIGN and make it the current layer.

[Cogo]-[Streets]-[SmpRoad]

Hal: ☐ Pick the HAL

[Window]-[2 Profile: chapter 13]

Val: ☐ Pick the VAL (in Profile view).

[Stations] Type in stations slightly less than the complete length of the VAL;

Begin Station: **71** End Station: **356**

[OK]

[Settings] Use X lines ☒

Template: ESTEMP

Roadway or ID name: ESCL

Dtm layer: POINTS

[OK]

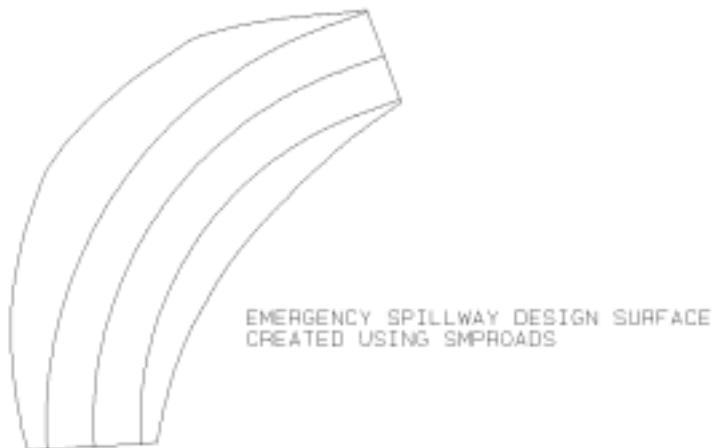
XLINES are not required to use the **SMPROAD** command. If not used, enter a station increment.

NOTE: IF YOU DO NOT USE XLINES AND FAIL TO ENTER A STATION INCREMENT, YOU WILL LOCK UP YOUR COMPUTER

[Window]-[1 Plan: chapter 13]

[SmpRoad]

Isolate the layer ESDESIGN to better view it.



7. Use the DTMSHOT command to find the slope intercepts at the ends.

First window in on the inlet end.

[DTM]-[DTM shot]

Layer: POINTS

Pt: ☐ pick the left end point of the 50' level section

Brg: (right click)-[Brg + Ang]

Brg: (right click)-[Of Line] ☐ Pick the line just above this point.

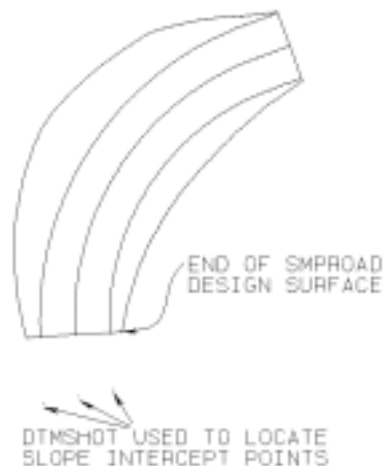
N2 39'46"W Notice that this is 180° from the desired orientation.

Ang: **180** (Enter **0** here if the bearing above was ok.)

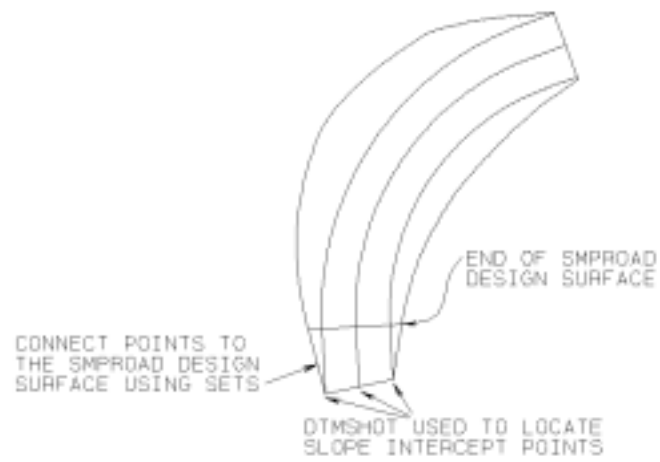
Vert: **-1%** (to continue inlet slope grade) **[OK]**

Repeat DTMSHOT on the remaining 5 points designating the bottom of the spillway. Remember the 4% outlet slope on the downstream end.

On some emergency spillway designs, DTM shot is unnecessary on all the end points. The slope intercepts may have been found with the SMPROAD command. This will not be true in every situation.



The DTMSHOT command only creates the points at the slope intercepts. Connect the points created using SETS and connect these sets to the design surface created with the SMPROAD command.



This is the completed design surface.



8. Check the design surface.

Prior to using the VOLUME command, the finished design surface should be checked for validity. Sometimes extra lines or erroneous lines are created that make the design surface invalid.

To check the design surface:

Change the color of Layer ESDESIGN.

Now, use the DTMEDGE command. This creates a boundary line of the points on the designed layer. This should overlay the perimeter of the design surface using a different color.

```
[DTM]-[DTM edge]  
DTM layer: ESDESIGN  
[OK]
```

If this DTMEDGE line matches the perimeter of the ESDESIGN layer, the design surface perimeter is okay.

If the DTMEDGE line does not match the perimeter line of the design surface, some editing must be done. If there is an extra line crossing the design surface (such as from one end of the curve to the other), try using BREAK on this line to remove it.

See the section in TM Note 4, Contour Maps or the TM command manual for information on editing surfaces.

Another check of the design surface can be made when using the Volume command (contouring the isopach layer).

9. Profile the final design surface.

If the design surface layer is the only one on, turn on the POINTS layer and the ES layer showing the HAL.

Make the HAL the ACTIVE alignment.

Use the PROFILE command on all of these layers in the same way as in step 2. When the profile is viewed ([Window]-[2 Profile: chapter13]), the original ground line, the original VAL, and the final design surface should be displayed.

See LABEL VAL in the Command Manual to label the vertical alignment as shown below.

